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PARTICULATE ORGANIC MATTER-CONTAMINANT ASSOCIATIONS AT THE WATER-SEDIMENT INTERFACE: BIOLOGICAL AND PHYSICAL CONTROLS

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LONG-TERM GOALS

The overall goal of this study is to build a framework for understanding processes influencing the association of contaminants with naturally occurring organic materials associated with suspended particles and surficial sediments. Specifically, we are using geochemical tracers, so-called "biomarkers", coupled with distributions of polycyclic aromatic hydrocarbons (PAHs) to identify sources of organic matter in the southern Chesapeake Bay (CB) and to understand the delivery, transformation and accumulation of natural and contaminant organic matter in coastal sediments.

SCIENTIFIC OBJECTIVES

The objectives of this project are: (1) to evaluate spatial and temporal variations in organic matter delivery and degradation processes in coastal waters, (2) to relate the composition of organic matter in sediments to physical and biologically-mediated transport processes in estuarine and coastal systems, and (3) to examine links between the fluxes and cycling of natural organic matter at the water-sediment interface and the transport and fate of organic contaminants. Within this framework, we will quantify various organic contaminants associated with sedimentary particulate matter, determine the seasonal fluxes of these substances at the water-sediment interface, and establish relationships, as possible, between natural organic matter and organic contaminant cycling in coastal and estuarine systems.

APPROACH

Suspended particles and surficial sediments have been collected and analyzed for biomarker compounds as well as one class of organic contaminants, the PAHs. Spatial and temporal changes in the composition of organic materials are being documented using elemental and molecular analyses. Specifically, total organic carbon (%OC, C/N ratios, and $d^{13}C_{OC}$), photosynthetically-derived carbon (inferred from chlorophyll a), total lipid, and two classes of lipid biomarker compounds (fatty acids and sterols) are being used to determine the sources of organic matter.

WORK COMPLETED

During FY1997 we completed a suite of cruises designed to examine spatial and seasonal variations in organic biomarkers and PAHs associated with suspended particles and surface sediments. This work focussed on sites within the CB Mainstem, at the mouths of two tributaries draining into the lower CB (York and Rappahannock Rivers), and a riverine site (Claybank in the York R.). All of the bulk measurements (%OC, C/N ratios, and chl a) are complete and more than half of the suspended particle samples have now been extracted. PAH analyses are complete on extracted samples and biomarker work is underway. In

addition, we completed biomarker and PAH analyses for samples collected during two experiments designed to examine tidal-cycle variations in the composition of POM. We have initiated the third component of our study, to assess the quality of organic materials associated with short-term accumulation events. The first of two cruises to examine down-core profiles of biomarkers and PAHs was conducted in July 1997. Beryllium-7 and organic carbon analyses are complete on those sediment cores.

RESULTS

Bulk measurements from our seasonal sampling indicate that our samples cover a range in particle quality and organic matter lability. Concentrations of particulate carbon and nitrogen fluctuated by nearly 6-fold and 8-fold, respectively. Chlorophyll concentrations ranged from 4-70 $\mu g\ l^{-1}$. Results from our second tidal cycle experiment (Cherrystone Flats) are now complete and show differences relative to our preliminary experiment in the York River. Analyses of suspended particles collected from 0.4 m from the bottom over a second tidal cycle showed TSP varied four-fold, whereas POC, PN, and particle-associated organic contaminants levels varied only two to three-fold at 0.4 m off the bottom during a typical tidal cycle. Unlike our previous work in the York R., tidal cycle variations in suspended particulates and particle-associated chemical concentrations were not well-correlated with bottom shear stress (r^2 = .19-.66), indicating that nonlocal particle advection plays a more important role in sediment and associated chemical transport in the lower CB. Biomarker compounds normalized to TSP varied by a factor of 3-4 over the tidal cycle and indicate organic materials are predominantly of algal origin with a smaller component of bacterial and terrestrial origin. Biomarker compounds were enriched at periods of low energy (slack) and depleted during periods of high energy (max ebb and flood).

IMPACT/APPLICATION

Our research has shown the importance of physical and biological processes in determining distributions of natural and contaminant organic matter associated with suspended particles and surficial sediments of a model estuary, southern CB.

TRANSITIONS

Through coordination of our field efforts, results from this study complement other ONR-funded studies (e.g., Schaffner and others) in the lower Chesapeake Bay.

RELATED PROJECTS

1. A research grant funded through VA Sea Grant and EPA (to R.M.D.) will support related work in the urbanized Elizabeth River, VA estuary.

2. An NSF supported project (E.A.C.) is currently investigating physical, biological and environmental processes controlling the distribution and lability of organic matter along the entire continuum of the Chesapeake Bay ecosystem. Results from this study will complement those obtained exclusively for the southern region as funded through ONR.